Amateur Stations

- **Amateur band allocations at 1.8, 3.5, 7.0, 10.1, 14.0, 18.1, 21.0, 24.8 and 28.0 MHz all the way to microwave**
- **Receiver sensitivity: –165 dBW (0.04 μV)**
- **Ambient noise levels: –155 dBW (0.1 μV)**
- **Antenna gain 2.2 dBi (free space) on 3.5 Mhz**
- **Antenna gain 7.5 dBi (free space) on 14-30 MHz**
- **Limited to 1500 watts PEP with no limits on antenna gain**
- **Up to 200 volts/meter field strength possible from amateur stations!**

Amateurs have bands in various portions of all HF (and above and below). Amateur receives are very sensitive, typically with a noise floor of –165 dBW (-135 dBm or 0.04 μV). Amateur noise levels can range from 10 to 30 dB higher than this in most installations.

Amateurs typically use half-wave dipoles or antennas with similar gain (2.2 dBi) on the lower bands and a small Yagi antenna on the higher bands (7.5 dBi or so). There are, however, many amateur stations that use much better antennas, so any calculations based on the typical numbers will not be "worst case." There is a wide range of amateur antenna systems to be found in residential neighborhoods.

There are presently over 650,000 licensed amateurs in the US. About half of these are active on the air from time to time, and about half are sometimes found on HF. This represents a pretty large interference potential for any unlicensed system that operates on HF.

They also radiate signals, so immunity issues may also present a problem for PLC and its customers. Some of the higher-powered amateur stations can radiate a signal of over 200 volts/meter to nearby locations.

Power Lines as Antennas

- **EZNEC 3.1 used to model 300 feet of simple electrical wiring (uses NEC-4, written by Lawrence Livermore National Laboratories)**
- **Terminated in 50 ohms – j 50**
- **Showed "gain" of –16 dBi to –7.8 dBi when over average ground**
- **Real-world installations – bigger radiators, but more loads on line**
- **Real world - multiple signals**
- **Real world – open light switches?**
- **Power companies have shown spotty compliance at correcting power-line noise...**

ARRL used EZNEC 3.1 with the NEC-4 engine to model a small power line. This simple model used two conductors, spaced 5 feet apart.

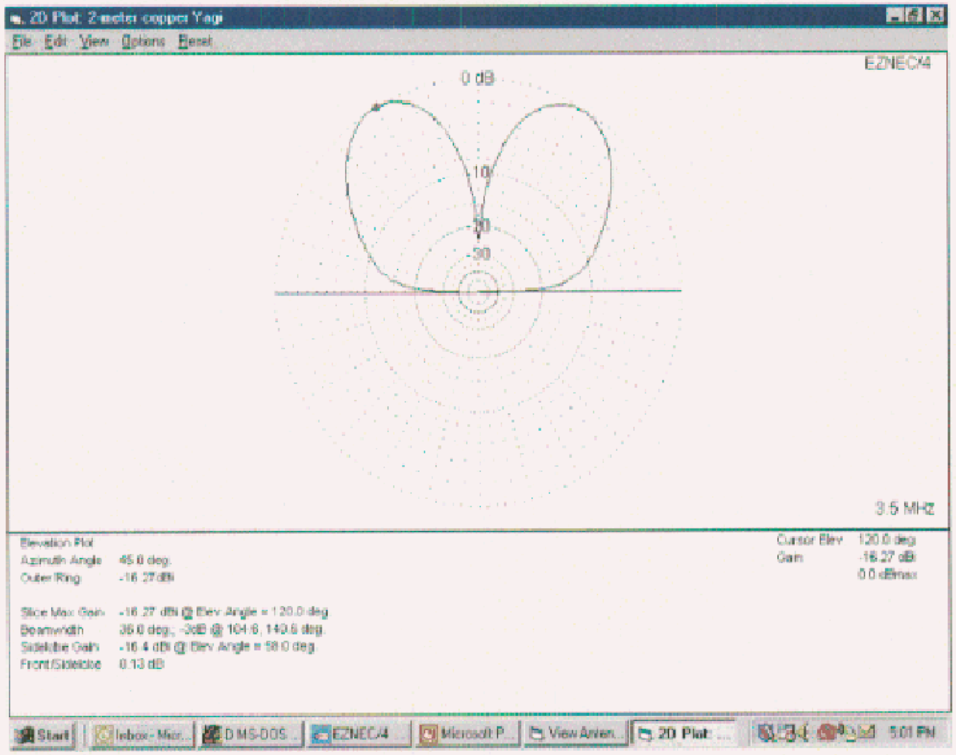
How will this power-line "antenna" perform? ARRL used EZNEC 3.1 with a NEC-4 engine to model a simple power line as an antenna. In the model, the line was fed differentially at one end, with a perfectly balanced signal. Some of the energy put into a power line will not be radiated, but will be lost as heat in the line, so a copper line loss was specified. A 50-ohm load with 50 ohms of capacitive reactance was put on the other end of the line. The model specified "good" ground conductivity and dielectric constant.

EZNEC calculated a gain of –16.0 dBi to –7.8 dBi from 3.5 to 14 MHz for this model. While not quite the monster antenna that some hams envisioned, power lines as radiators are comparable to a short mobile whip antenna on HF.

Real-world installations will be a bit more complicated. The radiator will be much larger than the simple model ARRL used. There may be more loads on the line to dissipate power. In the building electrical wiring, there will be open light switches and other "end-fed" wires present to radiate energy. There will often be multiple signals on the electric-utility line, whose radiated energy will add.

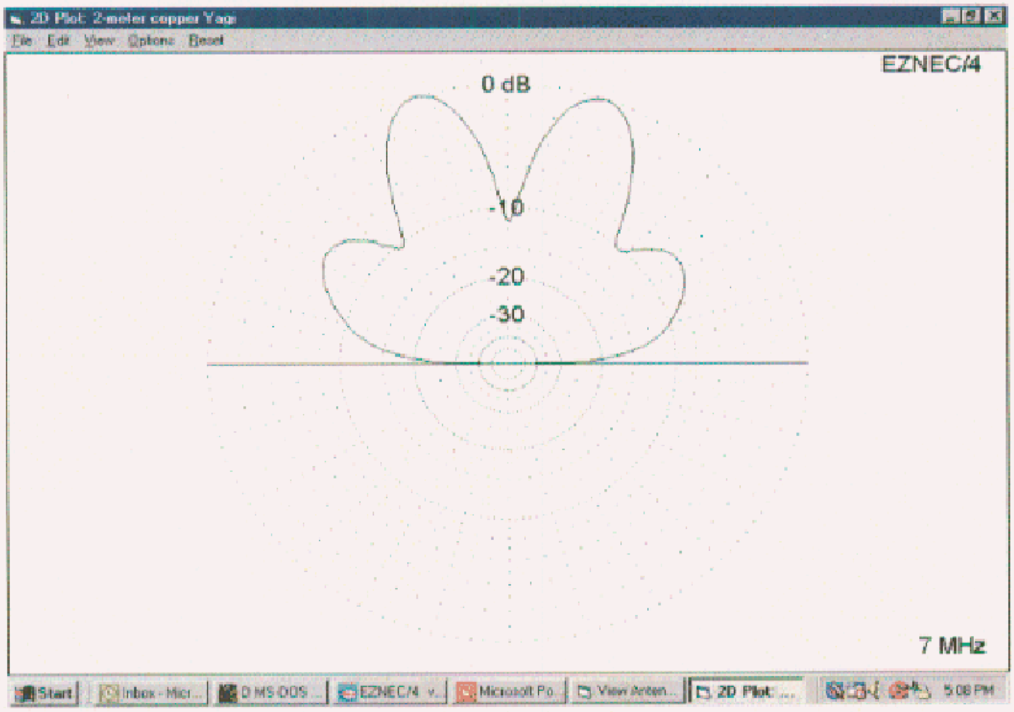
More important, access PLC systems will generally be deployed by electric utility companies. Over the years, utilities have been very inconsistent in their ability and willingness to correct harmful interference that results from things like cracked insulators or other defects on their power lines.

3.5 MHz pattern (–16 dBi)



This shows the predicted far-field pattern of the ARRL model used in this presentation. The system is relatively low to the ground, so much of its energy is radiated upward. In many cases, amateur antennas are located relatively high above ground, putting the receive antenna right in the "main lobe" of this noise transmitter.

7.0 MHz pattern (-7.8 dBi)



This is the pattern of the power line on 40 meters.

Far-field calculations:

Frequency = 3.5 MHz
Receiver bandwidth = 3000 Hz
Peak transmit power in 1 Hz = -50 dBm/Hz
Peak transmit power in 3000 Hz = -15.2 dBm (-45.2 dBW)
Distance to receiver = .03 km
Free-space path loss = -12.9 db
Power-line wiring antenna gain = -16.0 dBi
Receive antenna gain = 2.2 dBi
E field estimate in 9 kHz = 275 μV m peak (+ 48.8 dB μV /m)
Receive Noise Figure = 24 dB (includes external noise)
Calculated receive system sensitivity = -145.2 dBW
PEP received noise in receiver bandwidth = -72 dBW
PEP received noise in receiver bandwidth = S9 + 30.2 dB
PEP receive system noise floor increase in dB = 73.2 dB!

This is a calculation of the interference potential of PLC. It is an approximation because the calculation uses the path-loss formula to calculate the field at a point that is in the near field of the radiating element. This is, however, a reasonable calculation for physically large radiators, such as power lines. For point sources, however, the path-loss calculation would yield an estimate that is lower than the actual field might be, so this is a conservative estimate.

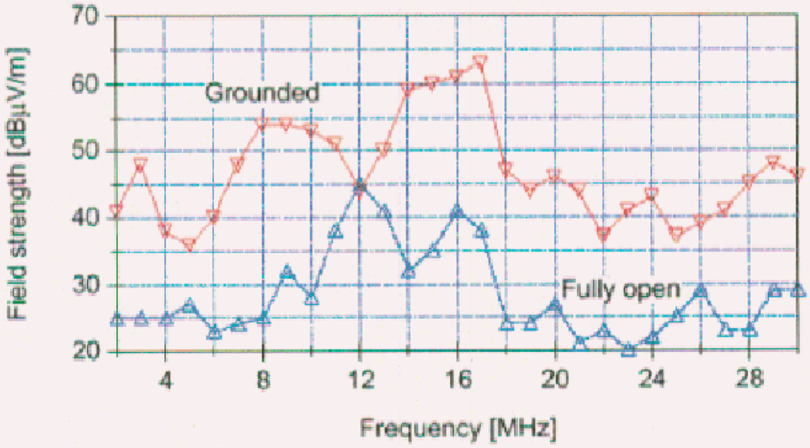
The frequency is 3.5 MHz and a 3000-Hz bandwidth SSB receiver was used. The transmit power was set to –50 dBm/Hz peak. The radiating source antenna gain was set to be –16.0 dBi and the receive antenna was presumed to be a half-wave dipole, at –2.14 dBi. The receiver noise figure was set to be 24 dB – assuming a fairly high local ambient noise level. (The best HF amateur stations could be 15 or more dB better than this.)

This calculation estimates that a noise level of –72 dBW (-52 dBm) will be received. This is an S9+30 dB noise that is 73.2 dB above the ambient noise level! There is absolutely no doubt that this is harmful interference that will completely obliterate any use of the band by this hypothetical amateur station!

In a 9 kHz bandwidth, the measurement bandwidth used on HF, this hypothetical PLC signal is 275 μV/m, exceeding the FCC limits by about 15 dB!

Takuma Experiment (2)

¶ **Field strength**



Large amount of emission is observed
Maximum antenna gain is −22[dBi]

These ARRL calculations are supported by actual measurements made by amateurs. These field measurements, made by XXX et al in Japan, show measured levels ranging from +35 dB μV/m to +65 dB μV/m from a PLC installation. This is from 1 dB to 31 dB more than what would be permitted by the FCC's rules.

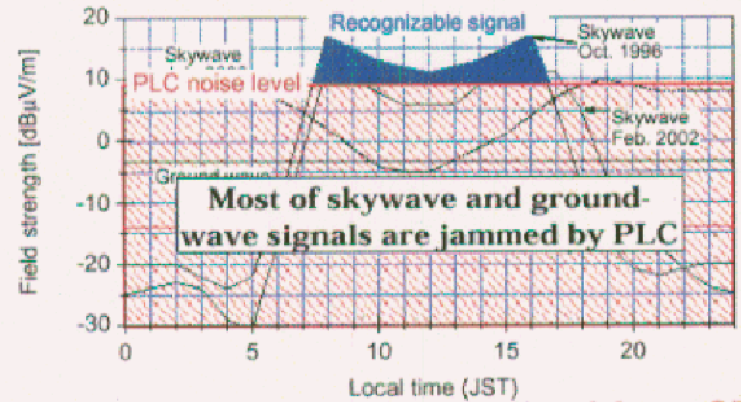
This slide provided courtesy of Cosy MUTO, JH5ESM. See last slide for link to ARRL page that links to the entire JARL report.

Akagi Joint Experiment (7)

¶ Field strength estimation of ground wave QSO

- Calculation based on ITU–R Rec. P.368–7

Sugamo to Akagi, 96[km], 7MHz 100W, λ/4 Vertical



Communications are time restricted, lower S/N

This is a strong enough level to mask all but the strongest of amateur signals. This graph shows that a few signals can be heard for the part of the day when HF propagation is at its best, with weaker signals completely buried in broadband noise. When the band is not optimum, but still filled with signals that could be easily worked, the noise makes the band virtually useless to amateur radio. These levels of signals would literally mean the end of any meaningful and useful HF Amateur Radio Service in areas where the system is deployed.

This slide provided courtesy of Cosy MUTO, JH5ESM. See last slide for link to ARRL page that links to the entire JARL report.

Analysis

- **Over 70 dB increase in peak local noise – on entire length of line – in entire neighborhoods! This is from a *single* PLC signal on an overhead power line line…**
- **Multiple signals: 10 signals will have at least 10 dB increase – possibly more on peaks, depending on how they add up**
- **Other losses might reduce the radiation potential of line**
- **Building wiring also involved – could add or subtract loss**
- **Japanese and Dutch measured studies showed similar results to ARRL calculations**

What is the bottom line? In these calculations, a single PLC on overhead power lines is predicted to cause a 70-dB+ increase in ambient noise near its operation. PLC systems will be deployed in entire cities or systems, so it is quite probable that every HF amateur in a given area with access PLC will have a nearby PLC installation. Multiple signals will add to the problem, by tens of dB in extreme cases. Actual measurements made by Japanese and Dutch amateurs have made the same determination.

40 dB/decade?

- **Common industry practice in US to make HF measurements at 3 meters and extrapolate to 30 meters "because the rules permit it."**
- **In this EZNEC model, on 3.5 MHz, in a separate calculation, the field strength at 30 meters distance from the source calculates to be 22 dB less than the field strength at 3 meters distance from the source**
- **In the VERON study, the measured field strength also fell off as approximately 20 dB/decade vs distance**
- **In the C63 PLC working group measurements test results submitted to C63 May 2002, the extrapolation method is off by +20 dB**
- **Is using 40 dB/decade and making measurements at 3 meters the only way some of these systems can "pass" FCC regulations?**

Where does this apparent 20 dB discrepancy between PLC systems and FCC rules come from? The FCC rules are designed to be as flexible as possible for those that must comply with them. A test distance of 30 meters might be difficult – or impossible – to achieve in some cases. Under these circumstances, the Part 15 rules permit a measurement to be made at another distance and extrapolated to the field strength that would be expected at 30 meters.

The rules say that if this is done, the manufacturer may make a measurement of the way the field varies with distance and apply that as an extrapolation factor. They also permit manufacturers to use a flat 40 dB/decade factor. This means that if a measurement is made at 3 meters, the field strength at 30 meters can be presumed to be 40 dB lower. In that case, instead of assuming that the power in the fields falls off as the inverse square of the distance, it will fall off as the inverse of the fourth power of the distance ratios involved.

This 40 dB/decade theoretical model applied reasonably well to very small sources. Unfortunately, it does not hold for systems that are many wavelengths long, such as an overhead power line on HF. All of the measurements and calculations made on these large systems indicate that a 20 dB/decade factor would be more appropriate.

For these physically large systems, if measurements on PLC systems are made at 3 meters and extrapolated to 30 meters, the fields at 30 meters are approximately 20 dB higher than the levels permitted under Part 15. It is likely that using a 40 dB/decade extrapolation is the only way these systems can be assumed to comply with the rules.

C63 PLC WG May, 2002 Report:

"Below 20 MHz, the FCC rules use/allow a different extrapolation than the Europeans, 40 dB/decade versus 20 dB/decade. Which, if applied, would cause the (5) PLC products measured to exceed the FCC limits by about 20 dB."

- **Extrapolation usually not very accurate, especially in near field**
- **If extrapolation MUST be used, 20 dB/decade is more accurate than 40 dB/decade**
- **This is supported by WG measurements, Japanese and Dutch Amateur Radio measurements and ARRL's NEC-4 antenna-modeling calculations**

The portion of this slide in quotes is an extract of the May, 2002 report of the C63 ad hoc PLC Working Group. One can conclude that extrapolation is not very accurate, especially in the near field. If it must be used, 20 dB/decade would be a much more reasonable factor to represent a reasonable worst case.

Field strength values normalized for NB 30 field strength at 3m are depicted in figure 8.

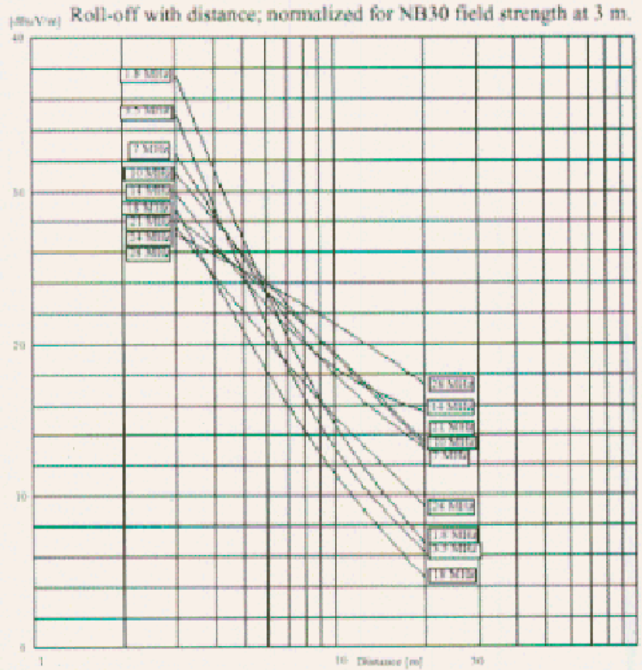


Figure 8.

From figures 7 and 8 we can conclude that the general assumption, that for all frequencies in this situation there is a linear decay, is only true for the statistical average over the 7 higher bands. At 1.8 and 3.5 MHz there is a faster decay.

This is one of the slides from the VERON report on PLC. It shows that for most frequencies, this tested PLC system showed a 20 dB/decade decrease in the field strength with distance.

This slide provided courtesy of Koos Fockens, PA0KDF. See last slide for link to ARRL page that links to the entire VERON report.

Do the FCC Rules Really Support This?

Sec 15.31(f) To the extent practicable, the device under test shall be measured at the distance specified in the appropriate rules section.

Do the rules really support making measurements at 3 meters – a common industry practice – and then extrapolating to 30 meters? Sec. 15.31(f) indicates that this can be done is if it not practical to make measurements at 30 meters. This may be true for some neighborhood deployments of PLC, but is it likely that all 3 of the typical installations that must be tested "must" be measured this way? If it is practicable to make measurements at 30 meters distance, the FCC rules say that should be done. Surely, one of the 3 typical systems could be selected on the basis of that practicability.

FCC Rules

Sec 15.31(f)(2) At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor of by using the square of an inverse linear distance extrapolation factor (40 dB/decade).

This is the provision in the rules that permits such extrapolations. Based on all indications that ARRL can identify, a 40 dB/decade extrapolation factor is not appropriate for PLC systems and should not be used.

FCC Rules

Sec 15.31(f)(4) When measurement distances of 30 meters or less are specified in the regulations, the Commission will test the equipment at the distance specified unless measurement at that distance results in measurements being performed in the near field.

Even if an extrapolation factor is used, this does not change the requirement that the field strength at 30 meters distance must be 30 μV/m or less. To the contrary, this part of the FCC rules suggests that the Commission will make measurements at the distance specified in the rules. Of course, 3 meters and 30 meters are both in the near field of an HF PLC system. The radiating power line may be tens of wavelengths long, resulting in a very large radiating near-field area. If the Commission investigates reported cases of harmful interference, they will probably verify that the field strength at 30 meters is indeed below the limits in the rules. It is also likely that the FCC would resolve the issue based on harmful interference, which can occur at levels well below the absolute-maximum limits in the rules.

Intent? My Opinion…

- **The rules intend to facilitate the easy determination of compliance**
- **They permit measurements at distances other than 30 meters to accommodate difficult or impossible measurement circumstances**
- **This accommodation is *not* intended to permit measurements to be made at other distances because measurements made at 30 meters do not exhibit compliance!**
- **What is the impact on manufacturers, consumers and radio services if there are widespread reports of harmful interference and the FCC makes measurements at 30 meters distance?**

The rules are written to facilitate easy determination of compliance. In some cases, it is simply not possible to make measurements 30 meters from the radiating source. For example, in some neighborhoods, points 30 meters from the power lines may be in places that are not accessible to test personnel. In other cases, adjacent power lines may be less than 30 meters apart.

However, the rules were not written to allow systems that do not meet the emissions limits at 30 meters to "pass" compliance by making measurements on 3 meters!

The rules are written to help manufacturers, the public and radio services avoid harmful interference. What is the impact on everyone if there are widespread cases of interference and the FCC makes measurements at 30 meters distance?

HomePlug Standard

- Uses building wiring to network computers within building
- -50 dBm/Hz level
- -80 dBm/Hz in HF ham bands
- ARRL testing with HomePlug showed modest interference potential even at –80 dBm/Hz
- ARRL and HomePlug agreed to disagree and would work together on harmful interference on a case-by-case basis
- At –80 dBm/Hz in the ham bands, that part of the spectrum probably meets the 30 μV/m at 30 m requirement by approximately 10 dB. What about the –50 dBm/Hz level?
- HomePlug systems only recently deployed, so no historical data for interference complaints

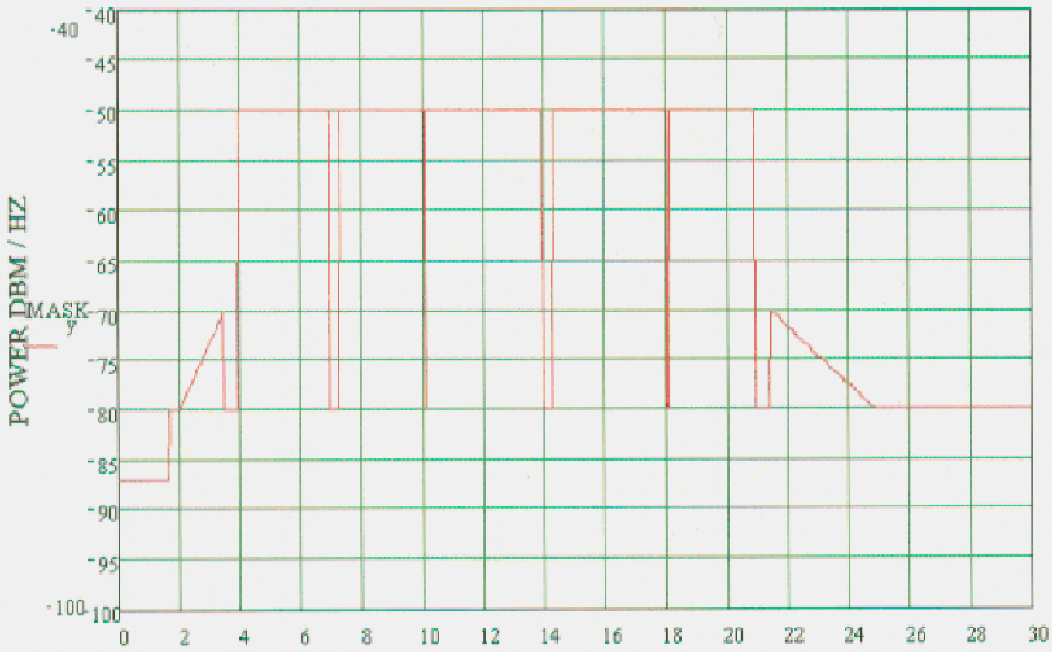
Even if measurements are made correctly at 30 meters, the absolute maximum limits in the Part 15 rules are high enough that harmful interference is likely. Those S9+ level signals from otherwise legal Part 15 radiators would cause harmful interference to almost all received amateur signals.

Although a manufacturer is responsible only for meeting those limits, in many cases, they end up assuming some responsible for harmful interference on behalf of their customers. As a minimum, there are very real costs associated with dealing with interference complaints, and as word of mouth about widespread interference spreads, it could well have an effect on product sales.

Many trade associations for similar products have recognized the need to offer additional protection to radio services that might be found near their products. For systems deployed in residential neighborhoods, it is quite likely that these systems will have nearby amateur radio operators.

Over the past few years, ARRL has worked closely and productively with several of these organizations. As a result of joint testing performed with ARRL, HomePlug has chosen to include a spectral mask (notches) in the HF ham bands. (There were a number of amateurs on the HomePlug working groups who well understood why it was in their employer's best interests to avoid widespread interference from their products.)

Although there is still some potential for interference, the specification has reduced their signal levels in the ham bands about 30 dB below what is required under Part 15. HomePlug chose to add the spectral masks to avoid the potential for widespread harmful interference to Amateur Radio in areas near HomePlug systems.



This is the spectral mask for HomePlug products. These notches were put in specifically to minimize the likelihood of harmful interference to amateur radio. Even so, this cannot protect against all cases of interference. If a ham has an indoor apartment antenna located several feet from a neighbor's electrical wiring, a HomePlug product in the neighbor's home will probably cause interference. HomePlug felt that the above 30-dB improvement in the amateur bands was the best they could manage, and ARRL and HomePlug agreed to disagree on the need for more protection. Both organizations left the door open to being able to address any such cases on a case-by-case basis. From ARRL's point of view, adding these notches to their products was well worth the doing!

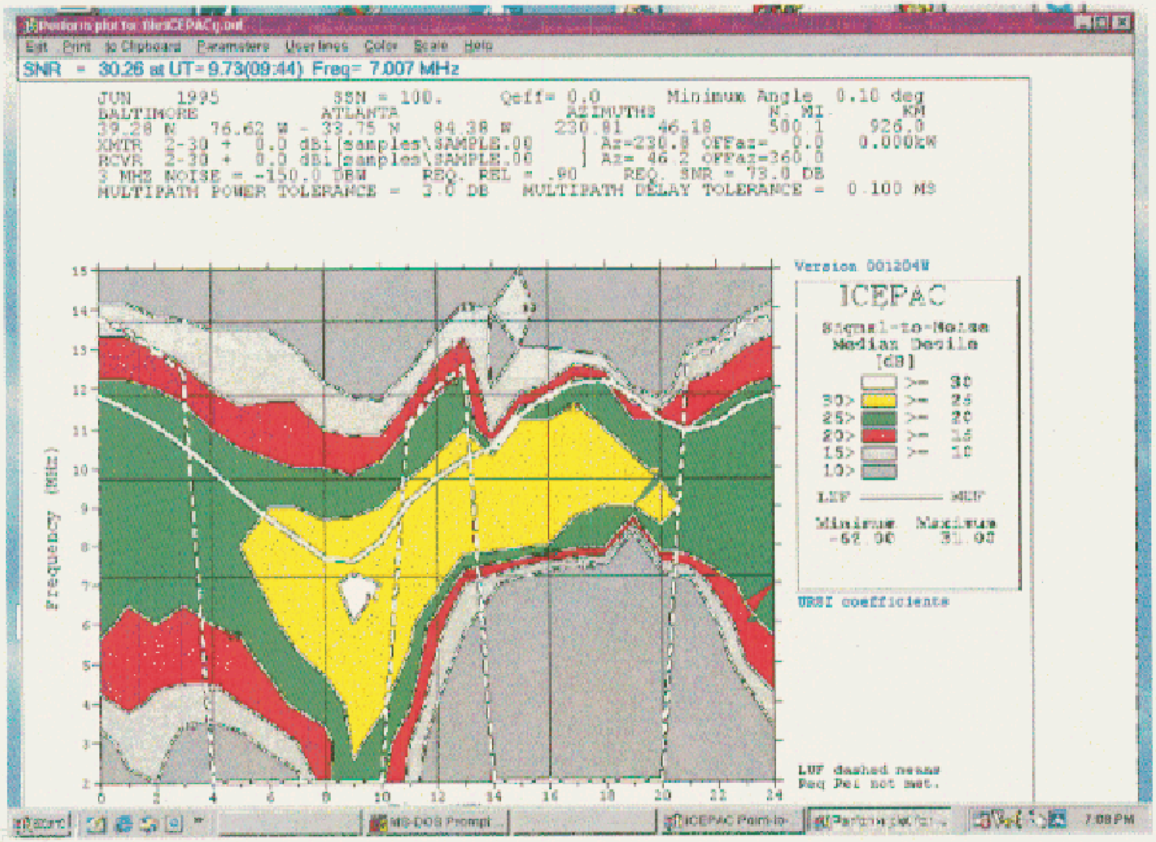
This slide provided courtesy of HomePlug. See last slide for link to ARRL page that has a link to HomePlug's home page.

Skywave?

- -50 dBm/Hz
- +10log(3000 Hz) = +34.8 dB
- -20 dBi
- 100,000 PLC users within several hundred miles of a particular location?
- +50 dB for 100,000 signals
- Total = -50 + 34.8 – 20 + 50 = +14.8 dBm EIRP
- +14.8 dBm PEP in every 3000 Hz from 2 to 15 (or more) MHz!
- If 1,000,000 signals, PEP = 24.8 dBm EIRP peak
- W1RFI has made contact with all 50 US states and all continents with power of +24 dBm and contact with 30 states with +10 dBm…

How far will PLC signals be heard? A level of –50 dBm/Hz has 10 nanowatts of power in every Hz of bandwidth. If this is heard by a 3000-Hz wide receiver, the "transmitter" will have –15.2 dBm in that 3000 Hz. This is a power level of 30 microwatts. This is not a lot of power and although it will be quite strong locally, it should not be heard much beyond a local area.

However, if there are hundreds of thousands of users in a region, these 30-microwatt signals can add up. For 100,000 PLC users in a given area, calculations on this slide show how the equivalent isotropically radiated power of all these individual PLC radiators in a large system can be +14.8 dBm or more. (14.8 dBm = 30.2 milliwatts). Amateurs on HF have worked worldwide communications with 30 milliwatts or less. Can PLC systems be heard hundreds of miles away?



This IONCAP run indicates that they can. This shows the expected S/N level between Baltimore, MD and Atlanta, GA in June, with a sunspot number of 100. The power level has been set to 30 milliwatts EIRP and the receiver has been given an ambient noise level that represents a residential neighborhood. The receiver antenna gain has been set to 0 dBi (isotropic).

IONCAP predicts that the 100,000 PLC signals radiated from the system in Baltimore could be received in Atlanta at a level that is more than 30 dB higher than ambient noise levels. If there were 1,000,000 signals in Baltimore, the levels could be 10 dB higher. Of course, all 100,000 would have to using PLC simultaneously, but the industry is certainly hoping for that level of market penetration!

PLC has the potential to raise noise levels by 10s of dB on a large scale well outside the communities in which they are deployed.

A Case History

- **Wireless modem jacks are carrier-current devices that use residential electrical wiring to couple modem signals between a computer and a remote telephone connection**
- **Phonex model PX-421 designed to operate on 3.53 MHz**
- **These were purchased in volume by TCI Cable (now AT&T) and installed in conjunction with their digital cable systems**
- **Widespread S9++ levels signals and harmful interference**
- **Phonex responded promptly, redesigned product**
- **AT&T still in midst of system-wide recall!**
- **Costs?**
- **PX-421 has not been manufactured for several years. The current Phonex wireless modem products do not pose a significant interference potential to amateur radio**

Manufacturers and power companies are apt to ask, "Can this cause me a problem?" There are a number of real-world cases of harmful interference that can be used to answer that question. Over the past few years, a number of operators of incidental emitters have received letters from the FCC, asking them to correct harmful interference from "conventional" power-line noise sources.

Another case involving carrier-current devices is a bit more telling. A few years ago, Phonex was manufacturing the PX-421 model wireless modem jack. This model used 3.53 MHz as one of its frequencies, near the lower edge of the amateur 80-meter allocation.

These products were purchased in volume by TCI cable (now AT&T/Comcast) and installed by the tens of thousands with TCI's digital cable systems. ARRL, TCI and Phonex received hundreds of reports of harmful interference at as much as S9 +50 dB!

Phonex responded promptly and properly – better than could have been imagined, in fact. Literally within weeks of their determining the cause of the reports, they had redesigned the product to use frequencies that would not be in common use in residential neighborhoods. A few weeks after that, the new model PX-441 was sent by air to be sent to TCI to resolve the strongest interference reports.

TCI also responded appropriately, at first agreeing to address reports on a case-by-case basis, but ultimately deciding that a system-wide recall of these devices was the only way to effectively address all of the reported cases. At this stage, they have removed about 95% of the product. A few were also sold through retail outlets, or used by satellite TV providers, so the ARRL still has a number of unresolved cases.

We can only imagine the costs to Phonex and TCI/AT&T to accomplish this. Resolving harmful interference in the field can be the most costly way to address this problem.

The Phonex model PX-421 has not been manufactured for several years and the current Phonex wireless-modem jack products do not pose a significant interference potential to amateur radio. Phonex also makes a HomePlug device.

Industry Measurements of Interference Potential?

- In general, industry has not made measurements of interference to other services
- Measurements and calculations made by Amateur Radio show significant interference potential
- Measurements made by the C63 ad hoc PLC Working Group also support this conclusion
- In cases where industry groups have conducted joint studies with ARRL, they have chosen to include spectral masks in their industry standards or specifications (HPNA, HomePlug, VDSL)
- To date, no widespread interference from protected products

In general, industry has not made measurements of interference to radio services. In the case of PLC, measurements and calculations made by amateur radio show a significant interference potential. This is supported by these calculations, ARRL's joint testing with HomePlug, the VERON PLC study and the JARL PLC study. The measurements made by the C63 PLC Working Group also show that the fields at 30 meters can be expected to be as much as 20 dB over the FCC limits, which are already high enough to cause harmful interference.

Of note, in all cases where industry has chosen to study harmful interference in cooperation with ARRL, that industry has chosen to voluntarily offer more protection in its product than the absolute-maximum limits in the FCC rules offer.

To date, there have not been widespread reports of interference from any protected product.

What is Needed?

- Based on modeling and calculations, -50 dBm/Hz will probably result in severe local harmful interference over wide areas
- These models are limited, but they clearly demonstrate clearly the need for further and immediate study
- Amateur Radio vs other services?

What should be done to address PLC and its radiated signals? All of these calculations and studies clearly indicate that a PLC level of –50 dBm/Hz will probably result in severe local harmful interference over a wide area. These models are not exact, but they demonstrate clearly the need for further and immediate study. The calculations estimate an increase of ambient noise of more than 70 dB. Even if the calculations were wrong by tens of dB, the interference potential of that "better" system would still be devastating to HF communications. Although ARRL is concerned only with amateur frequencies, these issues should be a concern to all radio services using HF spectrum.

What Would ARRL Like to Accomplish?

- ARRL wants to participate in field studies, with industry, through C63 and other organizations and with the FCC
- Although ARRL has serious reservations that access PLC can be accomplished without harmful interference, it is willing to work with industry to determine what PSD levels could be workable, if any
- Spectral masks or notches, as have been employed in related technologies, may be a possible solution
- Such notches will exist naturally in electrical wiring, so product must be robust enough to function with small segments of frequency band attenuated
- Advisory language in industry standards and specifications about harmful interference and the need for manufacturers to include such advisory information in their product literature
- ARRL will be firm in its expectation that cases of harmful interference from all Part 15 devices be corrected

ARRL wants to do more complete modeling and measurements, and work jointly with industry to do some field studies on systems in design and/or in field trial. Although ARRL has serious reservations that access PLC can be deployed without harmful interference, they are willing and interested in working with industry to determine what PLC levels can reasonably be used.

Low power levels and spectral masks may be ways to accomplish that goal. ARRL also hopes that the industry could include advisory language in its standards, industry specifications and equipment manuals that effectively address the issue of harmful interference.

Although ARRL is very interested in being a cooperative partner, it is also very firm that harmful interference to amateur radio must be addressed appropriately by the involved parties, as described in the FCC rules.

What's Next?

- More complete modeling and measurements
- Measurements: use –50 dBm/Hz noise source and make actual measurements of radiated emissions near residences. ARRL has designed test fixture and mobile measurement equipment for 3.5 MHz
- Can't easily do overhead wiring without industry cooperation
- ARRL expects to complete its first round of testing in the coming few months

ARRL has designed a broadband noise source that delivers –50 dBm/Hz. An associated test method can couple this power differentially onto power lines (or any other potential radiator, such as telephone wiring). It also has a mobile measurement set that can be used to measure both field strength and the increase in noise levels that might result from putting broadband, noiselike signals onto power-line wiring.

These tests can easily be performed on residential electrical wiring. Unfortunately, this can't be done to overhead electrical wiring without some cooperation from the electric-utility industry.

ARRL expects to complete some of this testing over the coming few months.

Speculation -- FCC Rules Changes?

- How should the rules treat PLC?
- Existing rules created to regulate intentional transmitters and systems that are generally "point" sources
- Impact and harmful interference from such systems generally local
- Were existing rules enacted to cover installations that may consist of thousands of signals on wiring plants that cover entire communities?
- When cable TV implemented, it used shielded wiring and controlled architecture
- Cable TV used VHF, where path loss is higher than HF
- Even so, the FCC imposed stringent cable rules that included both absolute individual leakage limits and a requirement for the system to meet stringent cumulative leakage limits
- Existing rules probably do not satisfactorily mitigate interference potential from PLC and related technologies
- With the availability of cable DSL, telephone-wire DSL, etc, do we really need another technology?

One burning question remains – are the present FCC rules appropriate for PLC? When the Part 15 rules for radiated and conducted emissions were first enacted, they were designed primarily for systems whose emissions were expected to be limited to a relatively small local area. Electric motors and computers, for example, would generally only be detectable for hundreds of feet. Even a community carrier-current AM radio station would be limited in scope, perhaps to a college campus or similar area. Can these same rules fairly be applied to installations on wiring plants and emissions that will cover entire communities?

When cable television evolved -- a similar technology in that it too covers entire communities -- the FCC determined that an entirely separate set of rules was necessary to regulate cable. By design, cable TV uses effective shielding that is not expected to radiate over most of the cable system. The rules do accept some degree of radiation, primarily from spot problems or customer-owned cable-ready equipment, carefully controlled through absolute-maximum radiated emissions limits.

The cable rules also contain a provision that cable operators must correct any leaks below that limit that cause harmful interference. They also have a requirement that the cable operator must even go so far as to terminate cable service to a building whose leakage exceeds the limit, even if the leaking component is not cable-company equipment! In addition, the rules also require that the cable company demonstrate periodic proof of performance, including measurements made of the cumulative leakage of the entire system.

If these stringent requirements are made of a system that is not expected to radiate under normal circumstances, operating on VHF and up where path loss is much higher than it is on HF, offering additional protection to nearby receivers, should not even more stringent requirements be placed on a system that is expected to radiate strongly in its entire area? The physical shape of overhead electrical wiring is such that it cannot attain the same amount of leakage protection that is typical of coaxial cable wiring.

With the availability of cable Internet access and several flavors of DSL, both of which use wiring that can act much more like a minimally radiating transmission line than PLC, is the addition of yet another way of achieving internet access really a necessary step? Adding this technology at the expense of completely trashing vast tracks of HF spectrum is not an appropriate step. The FCC rules for carrier-current devices should be closely examined to ensure that any new technologies that take advantage of those rules are regulated to the point where they will not cause widespread harmful interference on HF.

C63?

- **What interest should C63 have in PLC?**
- **C63 position statement?**
- **Continue ad-hoc study group?**
- **Regulatory comments?**
- **International position?**
- **ARRL willing to provide staff time as resource to C63**

ARRL will continue to work with manufacturers groups on PLC issues. One of these groups is the IEEE/ANSI C63 standards committee. At this stage, the committee is considering what its position should be and how it should bring its positions and recommendations to the FCC and to international groups such as CISPR. ARRL is one of many voices on that committee, ensuring that C63 and other groups have sufficient information about amateur radio to make informed decisions. ARRL will continue to make its staff resources available to this important work to protect the interests of amateur radio.